total-body doses associated with [^{18}F]FMISO PET imaging are comparable to or lower than those associated with other widely used clinical nuclear medicine procedures (*21–24*). The radiation exposure to the critical organ, the bladder wall, could be reduced slightly by increased frequency of bladder voiding.

Ongoing clinical trials using [^{18}F]FMISO-PET imaging will establish its appropriate role in the diagnosis and management of patients with tumors, ischemic heart disease and stroke, thereby defining the benefit. Should [^{18}F]FMISO-PET imaging be validated as a useful clinical test, this analysis indicates that the radiation absorbed dose resulting from the imaging procedure is favorable for further use of this imaging agent.

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Demonstration of Rectosigmoid Fistula Dynamic Scintigraphic Peritoneography

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Intraperitoneal installation of chemotherapy through a Mediport implanted subcutaneously in the abdominal wall is used currently for treatment of peritoneal metastases from ovarian, gastric and colonic carcinoma. There is a variable incidence of complications due to the procedure reported in the literature. The main predisposing factor for these complications is the inhomogeneous distribution of the chemotherapeutic drugs within the peritoneal cavity. We report an unusual case of a rectosigmoid fistula that developed 6 wk following the insertion of a Bardport subcutaneously in the abdominal wall for intraperitoneal therapy. The fistula was clearly demonstrated by dynamic scintigraphic peritoneography. This is a new modification of scintigraphic peritoneography as practiced routinely. We endorse the previous recommendation that scintigraphic peritoneography be performed before every intraperitoneal installation of a chemotherapeutic drug or radiopharmaceutical to ensure the homogeneous distribution of the drugs and to prevent complications.

Key Words: intraperitoneal chemotherapy; peritoneography; ovarian cancer; colon cancer; gastric cancer

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Intraperitoneal instillation of cisplatinum, interferon or ^{32}P chromic phosphate, alone or in combination with intravenous chemotherapy, has been reported as an acceptable approach for the treatment of peritoneal carcinomatosis in patients with ovarian, colonic or gastric carcinoma (*1–9*). To facilitate the frequent intraperitoneal installation of the chemotherapeutic drugs or radiolabeled phosphate, special catheters (modified Tenckhoff), needles (veress) or peritoneal ports have been

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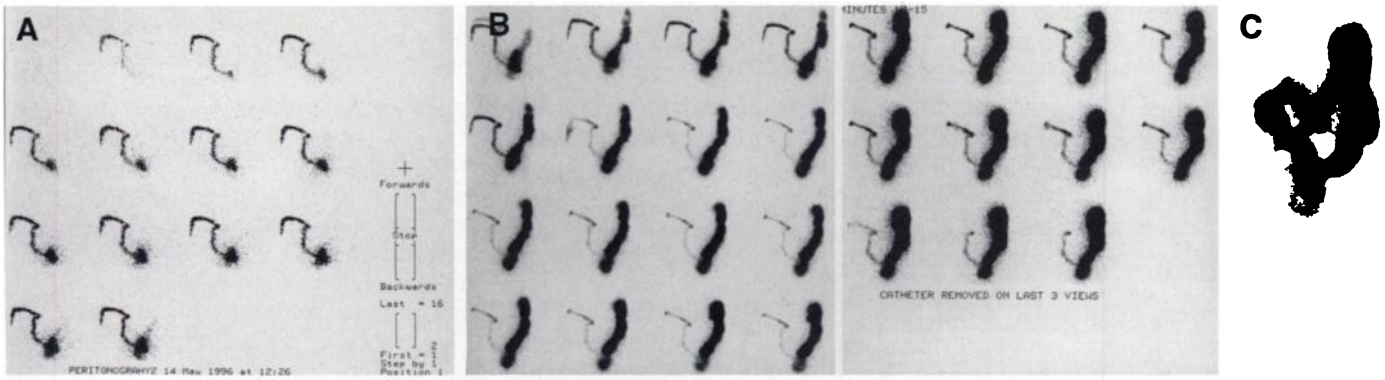

FIGURE 1. (A) Scintigraphic peritoneography. Dynamic images (flow 1) every 4 sec for 1 min demonstrating the fistula between the Bradport and the rectosigmoid. (B) Dynamic images (flow 2) acquired every 30 sec showing activity in the rectosigmoid and descending colon up to the splenic flexus. (C) Delayed static image showing activity in the colon all the way to the cecum.

recommended (*5,11,12*). Various complications of these treatments have been reported in the literature, including local crises within the abdomen and systemic untoward reactions (*14–18*). To prevent such complications and to ensure the homogeneous distribution of chemotherapeutic drugs throughout the peritoneal cavity, radionuclide peritoneal scintigraphy prior to treatment has been recommended (*9,16,20*). Intraperitoneal scintigraphy was also found to be helpful for the prediction of effectiveness of intraperitoneal chemotherapy (*20*).

This article describes a rare complication of intraperitoneal catheters, namely the development of a rectosigmoid fistula that developed 6 wk following the insertion of a Bardport catheter and describes its diagnosis by dynamic scintigraphic peritoneography. The literature concerning the complications commonly encountered with intraperitoneal cancer therapy also is reviewed.

CASE REPORT

A 74-yr-old woman with a history of hypertension, mitral valve prolapse, diverticulosis and a hiatal hernia is presented. In April 1995, the patient complained of irregular bowel movements and abdominal pain. A mass was discovered on physical examination posterior to the uterus and an abdominal sonogram suggested the presence of an ovarian neoplasm. Her pre-operative CA-125 was markedly elevated at 1117 units/ml. In May 1995, the patient had an exploratory laparotomy, which revealed a serous adenocarcinoma of the ovary with extensive peritoneal spread. Tumor deposits were present on the liver surface, diaphragm, stomach, rectosigmoid colon and omentum. The patient had a total abdominal hysterectomy and bilateral salpingo-oophorectomy, aortic lymph node sampling and resection of the sigmoid colon, appendix and omentum. Pathologically, the tumor proved to be a moderately differentiated serous papillary adenocarcinoma of both ovaries, invading the fallopian tubes, parametrial tissue, bowel wall and gastroduodenal junction. Despite this debulking surgery, significant gross disease remained and she was classified as having FIGO Stage IIIB disease. Subsequently, the patient was treated with Taxol and Carboplatin chemotherapy. She completed six cycles of this regimen, at full doses and on schedule, between June and November 1995. Her therapy was complicated by the development of a severe peripheral neuropathy resulting in bilateral foot drop. Her disease responded to treatment with a gradual reduction in her CA-125 tumor marker from 400 μ/ml to 40 μ/ml. It was felt, nevertheless, that the patient had a suboptimal response to treatment and still had residual tumor present, for which further treatment was required. However, the patient was discouraged by her neuropathic symptoms, and failed to return for follow-up until March 1996. By that time, her CA-125 level had increased to 182 μ/ml.

On March 27, 1996, the patient underwent exploratory laparoscopy to restage her cancer, and for insertion of a Bardport access device for intraperitoneal therapy. At laparoscopy, no evidence of gross disease in the peritoneal cavity was visualized. There were significant adhesions to the anterior abdominal wall that were lysed. Biopsies of the peritoneum showed atypical cells suggestive of malignancy similar to the original tumor. At that time, it was felt that the patient might benefit from intraperitoneal ^{32}P treatment since she had already developed neurological complications from chemotherapy, her disease was microscopic, and there is no known cross-resistance between chemotherapy and radiation. On May 6, 1996, the patient had peritoneal scintigraphy in anticipation of intracavitary brachytherapy. Following the intraperitoneal installation of 250 ml of saline through the Bardport, 1.0 mCi ^{99m}Tc sulfur colloid was injected with the patient in different positions. The static images showed surprising findings of activity in the ascending, transverse, descending and rectosigmoid colon. A thin band of activity was detected across the peritoneum in the right lower quadrant that was difficult to identify. On May 10, 1995, a repeated scintigraphic peritoneography was performed using a modification of the technique; 2 mCi ^{99m}Tc sulfur colloid were diluted in 50 ml of saline and infused through the Bardport.

Dynamic images of the anterior abdomen were started during the infusion every 4 sec for 1 min, followed by 30 sec images over the next 30 min. The first dynamic images demonstrated a fistula between the Bardport and the recto sigmoid colon (Fig. 1A). The second dynamic images demonstrated ascent of radioactivity through the descending colon toward the splenic flexure (Fig. 2B). Static delayed image acquired after the patient was turned in different positions showed activity in the colon all the way to the cecum (Fig. 1C). Subsequently, the patient underwent surgical repair of the fistula, removal of the catheter and the Bardport and creation of a temporary diverting colostomy. The fistulus track was closed primarily in two layers and the areas were patched with a loop of small bowel. Postoperative recovery was uneventful and the patient was discharged 1 wk later.

DISCUSSION

Complications following the intraperitoneal installation of chemotherapy using implantable subcutaneous port systems are quite frequent, despite various precautions recommended to minimize their occurrence. Maruyama et al. (*14*) reported complications in 15 of 54 patients with gastrointestinal carcinoma treated with intraperitoneal chemotherapy through such devices, which included bowel perforation, retention of ascites, intra-abdominal infections, inflow obstruction and pain in the perineal and lower abdominal area. Seven patients required removal of the device due to these complications. They recommended the use of a softer catheter in the abdominal cavity; its tip should not touch the bottom of the pelvic floor. They also recommended the use of prophylactic antibiotics to be applied

in and around the port, and steroids to be added to the solutions used for intraperitoneal chemotherapy.

Adachi et al. (*17*) reported the complications that developed in 84 patients treated with intraperitoneal cisplatin. Thirty-nine patients were treated using temporary catheters and 45 had implantable ports and catheters inserted. Twenty-seven percent of temporary catheter patients experienced complications with infection in 8%, inflow obstruction in 3%, leakage in 5%, extrusion in 8% and severe pain in 3%. Furthermore, a total of 22 patients with an implantable port and catheter system experienced complications, including inflow obstruction in 9%, infection in 2%, leakage in 4% and extrusion in 7%.

Esquivel et al. (*18*) reported the morbidity and mortality of cyto-reductive surgery and intraperitoneal chemotherapy in 43 patients with peritoneal caricnomatosis treated over an 18-mo period. Twenty-one complications occurred in 17 patients (37.7%). Infectious complications included pancreatitis and anastomotic disruption in one patient each, and fistula and bile leakage in four patients. There were two early and two late episodes of postoperative bleeding requiring re-operation. As a result of their findings Esquivel et al. (*18*) concluded that intraperitoneal chemotherapy should be recommended only for patients with low volume, intra-abdominal cancers. In most cases, surgical debulking of peritoneal carcinomatosis is recommended before intraperitoneal chemotherapy is administered. Because of the significant morbidity related to the treatment of peritoneal carcinomatosis, careful patient selection for favorable prognostic features is required.

Nguyen et al. (*11*) reported his preliminary experience using a modified Tenckhoff catheter for intraperitoneal chemotherapy in a review that involved 137 catheters implanted in 125 patients with ovarian cancer, treated between June 1988 and December 1990. A total of 559 cycles of intraperitoneal chemotherapy were given, with a range of 1–16 uses per catheter. Complications included infections in 6%, inflow obstructions in 3.4%, bowel perforation in 2.6% and leakage in 0.8%. Wei et al. (*23*) reported an analysis of the complications associated with intraperitoneal catheters, implanted in 115 patients with ovarian malignancies, who were treated at People's Hospital, Beijing Medical University between May 1976 through August 1991. A total of 191 catheters were inserted and complications were found in (25.2%). Infections were reported in 4.3%, partial intestinal obstruction in 1.7%, pain in 3.5%, inflow obstruction in 10.4% and falling off of the catheters in 5%. It would appear from these studies that implantable intraperitoneal catheters are useful, but that complications may be expected in approximately one-third of patients who receive them.

Other studies suggest that intraperitoneal chemotherapy should not be used pre-operatively or in the early postoperative period. Adachi et al. (*15*) reported his experience with preoperative intraperitoneal chemotherapy administered to 23 patients with gastric cancer to inhibit peritoneal recurrences. The chemotherapy was administered intraperitoneally 3 days prior to surgery, at which time a very viscid peritoneum and mucinous intraperitoneal fluid were reported in 100% and 83% of patients, respectively. Inflammatory changes were observed microscopically in the subserosal layer of the resected stomach and in the intraperitoneal fluid, but cytologic changes of a drug response within the cancer cells could not be seen. He concluded that intraperitoneal chemotherapy in this setting had no definite benefits nor effects on survival, but was frequently associated with peritoneal complications. Ivarsson et al. (*15*) recommended that intraperitoneal chemotherapy should not be used in the early postoperative period because of delayed wound healing.

To minimize these complications and predict the effectiveness of intraperitoneal chemotherapy, and for follow-up, radionuclide peritoneography has been used successfully. Sugimura et al. (*20*) used intraperitoneal scintigraphy with ^{99m}Tc MAA in nine patients with carcinomatous peritonitis to predict the effectiveness of intraperitoneal chemotherapy in patients with advanced ovarian carcinoma. Patients with a good distribution of ^{99m}Tc on intraperitoneal scintigraphy responded well and intraperitoneal chemotherapy was effective. In contrast, intraperitoneal chemotherapy was not effective in patients with only local diffusion of the radioactive tracer. Quantitation of the distribution of the radioactivity in the different quadrants of the peritoneal cavity is useful to ensure the homogenity of the distribution of radioactivity.

DeForni et al. (*16*) concluded from his study that repeated scintigraphic peritoneography is useful for identifying patients who are no longer suitable for intraperitoneal treatment due to inadequate loco-regional distribution. Twenty-one patients undergoing either adjuvant or palliative intraperitoneal chemotherapy were followed in a prospective study using serial scintigraphic peritoneography. Significant scintigraphic intraperitoneal changes were recorded over the course of therapy in 11 patients (52%). Even in patients without residual disease initially, the rate of intraperitoneal maldistribution reached 70% after repeated treatments with intraperitoneal chemotherapy.

Another approach to minimize complications from these catheters has been the use of flouroscopy and contrast peritoneography to guide their insertion. Rundback et al. (*19*) suggested that the surgical insertion of intraperitoneal catheters for intraperitoneal chemotherapy be performed with fluoroscopy. Two hundred and one intraperitoneal catheter placements were attempted in 88 patients with peritoneal carcinomatosis or sarcomatosis. The peritoneum was punctured with 22 gauge needles and exchanged for 8.3–8.5 F multiple-side whole catheters using the Seldinger technique and liberal injections of contrast material at each step of the procedure. CT peritoneography was performed prior to chemotherapy administration. The catheters were placed accurately in 94.5% of the cases. Free distribution of peritoneal contrast material using CT peritoneography was achieved in 39%, partial loculation was demonstrated in 38% and extensive loculation was present in 22% of patients. Catheters remained in place for a median of five days. Unintended bowel intubations occurred in four procedures (5.5%). Three patients were treated conservatively and one patient required surgical repair of the bowel perforation.

CONCLUSION

There is a wide variation in the incidence and type of complications following intraperitoneal catheter insertion and intracavitary installation of chemotherapeutic agents. We strongly endorse the use of scintigraphic peritoneography before each administration of intraperitoneal chemotherapy or radiopharmaceutical. Quantitation of the percent uptake of the total injected dose in each quandrant of the abdomen is an easy way to follow these changes.

Visualization of the peritoneal cavity before each installation of chemotherapy has proven to be effective and is recommended highly. Contrast peritoneography with CT imaging is cumbersome, costly and inconvenient. Peritoneal scintigraphy is easier and safer than CT scanning and more accurately predicts the ability of the therapeutic agent to be distributed evenly throughout the whole peritoneal cavity. Dynamic images

acquired at the time of intraperitoneal injection of the radiopharmaceutical, as described in this case report, allow visualization of early flow in the peritoneal cavity.

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